NTRC NANOTECHNOLOGY RESEARCH CENTER
National Institute for Occupational Safety and Health

# 3D Printing with Metal Powders: Health and Safety Questions to Ask

**Review the questions on the left and explore different control options and other information to reduce your exposure on the right.**

## 1 Characterization of Potential Hazards

What potential hazards are associated with metal powder 3D printing? What metals are in the powder? Are there known health effects from the metals (see safety data sheets) or can they be reactive with the air? What is the work environment like (for example, an open or isolated area)?

### Potential hazards may include:

- Breathing and skin contact with metals
- Static, fire and explosion
- High powered lasers

### Printing considerations:

- Printer locations
- Grounding and bonding straps used when removing filters
- Written procedures covering receiving and disposal of metal powders, operation and maintenance activities

### Work environment best practices:

- Print in a negatively pressured area with a dedicated ventilation system, in an area away from other work
- Appropriate fire suppression system

## 2 Work Activities

Could the work activities cause exposure? How are you handling the metal powders? What is the likelihood of exposure? Can you change the way you do the activity to reduce the likelihood of exposure (high potential to low)? Be aware of the other printing activities occurring nearby.

### Pre-printing

**Higher potential for exposures:**
- Loading powders manually into machine
- Sieving powder outside of machine

**Lower potential for exposures:**
- Enclosed powder loading
- Enclosed powder sieving
- Receiving and storing powder containers

### Printing

**Higher potential for exposures:**
- Other work activities nearby

**Lower potential for exposures:**
- Monitoring printing progress (printing with metal powders is typically performed in an enclosed chamber, and the potential for exposure to emissions is low)

### Post-printing

**Higher potential for exposures:**
- Removing powder or printed object from printer
- Moving powder/printed object around work area

**Lower potential for exposures:**
- Post-process cleaning/finishing object inside containment system
- Enclosed powder sieving and powder removal

### Maintenance and cleaning

**Higher potential for exposures:**
- Performing preventative maintenance on printer
- Removing/installing high efficiency particulate air (HEPA) filters

**Lower potential for exposures:**
- Cleaning printer equipment and tools
- Housekeeping

## 3 Engineering Controls

Based on the work activity or step in the printing process, what engineering controls will reduce the likelihood of exposure? What are the key design and operational requirements for the control? Consider fire and explosion hazard of metal powder when selecting controls.

### Pre-printing

- Containment or local exhaust ventilation close to powder handling activities (should be HEPA-filtered and fire/explosion appropriate)

### Printing

- Printing with metal powders is typically performed in an enclosed chamber, and the potential for exposure to emissions is low

### Post-printing

- Controls listed for pre-printing
- Ventilated glove box or containment system (for example, during cleaning and finishing activities)
- Ventilated sieving or powder dumping stations

### Maintenance and cleaning

- Local exhaust ventilation when handling powders outside of containment
- HEPA-filtered and fire/explosion-appropriate waste vacuum
- Grounding and bonding of equipment for static, fire and electrical safety
- Sticky mats on floors at printing or powder handling area exits/entrances

## 4 Administrative Controls

Have you considered your workplace practices and policies? Have you set up a plan for waste management? Have you considered what to do in case of a spill?

### Applies to All Printing Stages

- Incorporate metal powder 3D printing into workplace safety programs
- Develop standard operating procedures and train workers
- Do not consume food or drinks in work areas
- Restrict access to essential personnel
- Properly handle filters during replacement, removal, and disposal, and check and replace seals as needed
- Use signs to alert workers of hazards and appropriate actions to protect themselves
- Consider the reactivity of your base material when selecting cleaning materials, equipment, and methods
- Clean work areas frequently including between prints and at least daily
- Use wet cleaning methods (do not dry sweep or used compressed air)
- Handle and dispose of all waste materials (including cleaning materials/gloves) in compliance with all applicable federal, state, and local regulations

## 5 Personal Protective Equipment (PPE)

If the measures above do not effectively control the hazard, what PPE can be used? Have you considered PPE for other safety hazards (such as static, fire, explosion, and laser)?

### Applies to All Printing Stages

Wear PPE that is appropriate for the activities around you (for example, powder change out on the machine next to your work station may require you to wear the same level of PPE). While potential exposures are typically lowest during the printing stage, work surfaces might still be contaminated with metal powders. If printing is interrupted, use the level of PPE needed when the machine is open. Follow proper PPE replacement practices. Do not wear PPE outside of work areas. Options for PPE include:

- Nitrile or chemical resistant gloves
- Lab coat or coveralls
- Safety glasses, goggles, or face shields
- Respiratory protection when indicated and engineering controls cannot control exposures, and in accordance with federal regulations (29 CFR 1910.134)
- NIOSH guidance on respirators can be found at www.cdc.gov/niosh/topics/respirators/

CDC NIOSH Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health

**Learn more about safely working with metal powders for 3D Printing**

DHHS (NIOSH) Publication No. 2020-114, https://doi.org/10.26616/NIOSHPUB2020114 | March 2020